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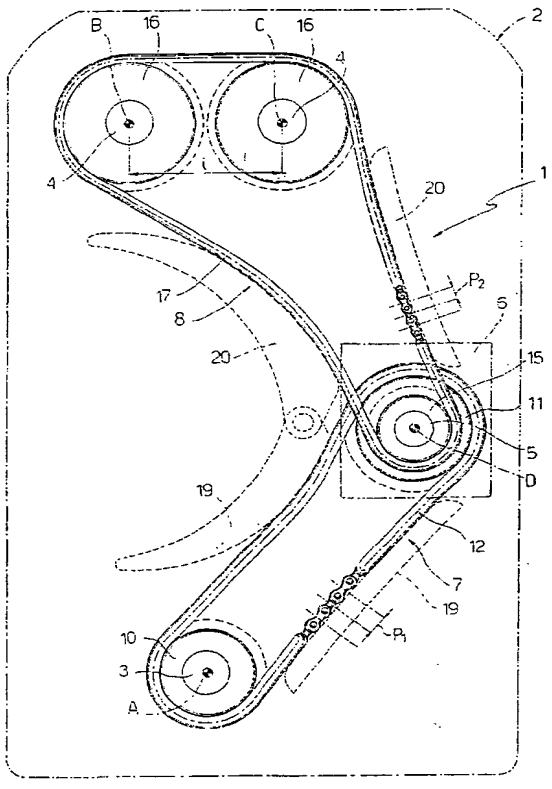
(54) Camshaft chain drive for a double overhead camshaft internal combustion engine

(57) A chain transmission device (1) for controlling the timing system of an internal combustion engine (2) with two overhead camshafts (4), and having a first chain transmission (7) from the drive shaft (3) to an intermediate shaft (5), and a second chain transmission (8) from the intermediate shaft (5) to both the camshafts (4); and wherein the first transmission (7) defines a step-down transmission ratio (t_1) between the drive shaft (3) and the intermediate shaft (5) ; the second transmission (8) defines a step-down transmission ratio (t_2) between the intermediate shaft (5) and the camshafts (4); the chain (17) of the second transmission (8) has a pitch (p_2) smaller than the pitch (p_1) of the chain of the first transmission (7); and the intermediate shaft (5) is defined by the drive shaft of a fuel pump (6) of the engine (2) .



EP 1 046 790 A1

Description

[0001] The present invention relates to a chain transmission device for controlling the timing system of an internal combustion engine with two overhead camshafts.

[0002] Single-chain control of both the camshafts of internal combustion engines of the above type poses serious problems in terms of size.

[0003] That is, the distance between the axes of the camshafts is a design feature which depends on the valve arrangement, and, for reasons of size, should be as small as possible.

[0004] On the other hand, the drive shaft the camshafts have a specific transmission ratio (1:2), which means, assuming both camshafts are controlled by a single chain controlled by a sprocket on the drive shaft, the diameter of the driven sprockets on the camshafts is twice the diameter of the drive shaft sprocket.

[0005] As the pitch of the chain is substantially imposed by the power transmitted, and the number of teeth, and hence the diameter, of the drive shaft sprocket cannot be reduced beyond a given limit, the resulting diameter of the driven sprockets is fairly large and incompatible with the design distance between the camshaft axes.

[0006] In some known engines, the problem has been partially solved using two chain transmissions in series with each other : a first transmission from the drive shaft to an idle intermediate shaft, and a second transmission from the intermediate shaft to the two camshafts. Such a solution, however, is relatively complex and expensive, by calling for an additional intermediate shaft, which serves no other purpose, and for respective supporting means on the engine.

[0007] It is an object of the present invention to provide a chain transmission device for an internal combustion engine with two overhead camshafts, designed to overcome the aforementioned drawbacks in a straightforward, effective, low-cost manner.

[0008] According to the present invention, there is provided a chain transmission device for controlling the timing system of an internal combustion engine with two overhead camshafts, and comprising a first chain transmission from the drive shaft to an intermediate shaft, and a second chain transmission from the intermediate shaft to both said camshafts; wherein said first transmission defines a step-down transmission ratio between said drive shaft and said intermediate shaft; and said second transmission defines a step-down transmission ratio between the intermediate shaft and the camshafts; characterized in that said intermediate shaft is the drive shaft of a fuel pump of said engine; and in that the chain of said second transmission has a pitch smaller than the pitch of the chain of said first transmission.

[0009] A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawing.

[0010] Number 1 in the accompanying drawing indicates as a whole a chain transmission device for controlling the timing system of an internal combustion engine, in particular a diesel engine, 2.

[0011] Engine 2 comprises a drive shaft 3 of axis A and angular speed ω_M; and two overhead camshafts 4 of speed $\omega_C = \frac{1}{2}\omega_M$ and having respective axes B, C parallel to each other and to axis A and separated by a distance i.

[0012] Engine 2 also comprises an intermediate shaft 5 for driving a high-pressure fuel pump 6 forming part of a storage injection system (not shown). Using a storage system allows a certain amount of freedom in selection of the angular speed (ω_I) of pump 6, i.e. of intermediate shaft 5. In such a system, the speed of the pump is preferably the same as that of the drive shaft, or lower according to the equation $N/2*n_p$, where N is a whole number, and np the number of pumping members (normally 3 or 4) of the pump. Such a relationship ensures a whole number of pumping strokes in each engine cycle (two revolutions of the drive shaft), and hence a known constant phase relationship between variations in the feed pressure of the injectors and the points in the engine cycle - predetermined and the same for each cycle - at which pressure is determined by the electronic injection control system (as is known, in storage systems, the amount of fuel injected is controlled electronically by varying the opening time of the pins).

[0013] In the case of three pumping members, pump speed must equal N/6 the engine speed, e.g. 5/6.

[0014] Device 1 comprises a first chain transmission 7 interposed between drive shaft 3 and intermediate shaft 5; and a second chain transmission 8 interposed between intermediate shaft 5 and the two camshafts 4.

[0015] First transmission 7 comprises a drive sprocket 10 fitted to drive shaft 3, a driven sprocket 11 fitted to intermediate shaft 5, and a chain 12 meshing with sprockets 10 and 11; and the number of teeth of sprockets 10, 11 is such as to achieve, between drive shaft 3 and intermediate shaft 5, a step-down transmission ratio $t_1=\omega_I/\omega_M$ ranging between ½ and 1 and, for the reasons given above, conveniently defined by a fraction $N/2*n_p$, e.g. 5:6. By way of example, sprockets 10 and 11 may comprise 25 and 30 teeth respectively.

[0016] Second transmission 8 comprises a drive sprocket 15 fitted to intermediate shaft 5, a pair of driven sprockets 16 fitted to respective camshafts 4, and one chain 17 meshing with sprocket 15 and both sprockets 16. The number of teeth of sprockets 15, 16 is such as to give a transmission ratio $t_2=\omega_C/\omega_I$, which, together with first transmission 7, defines a total step-down ratio 1:2 between drive shaft 3 and each of camshafts 4. In the example shown, t_2 equals 3:5, and sprockets 15, 16 may comprise 24 and 40 teeth respectively.

[0017] According to a further characteristic of the present invention, chain 17 may be sized for less power, and therefore have a smaller pitch, than chain 12. By way of example, the two pitches may be 8 and 9.525

mm respectively.

[0018] Chains 12 and 17 are guided in the usual way by respective pairs of shoes 19, 20; and one of the shoes in each pair is movable by elastic means (not shown) to tension the respective chain.

[0019] The advantages of device 1 according to the teachings of the present invention will be clear from the foregoing description.

[0020] Using shaft 5 of pump 6 as an intermediate shaft for both transmissions 7, 8 provides for achieving a two-stage step-down ratio with no need for an idle intermediate shaft which serves no other purpose.

[0021] Moreover, the smaller pitch of chain 17 as compared with chain 12 provides for reducing the diameter of sprockets 16 of camshafts 4, and hence distance i between the relative axes.

[0022] Clearly, changes may be made to device 1 without, however, departing from the scope of the accompanying Claims. In particular, the transmission ratios of the individual transmissions may vary.

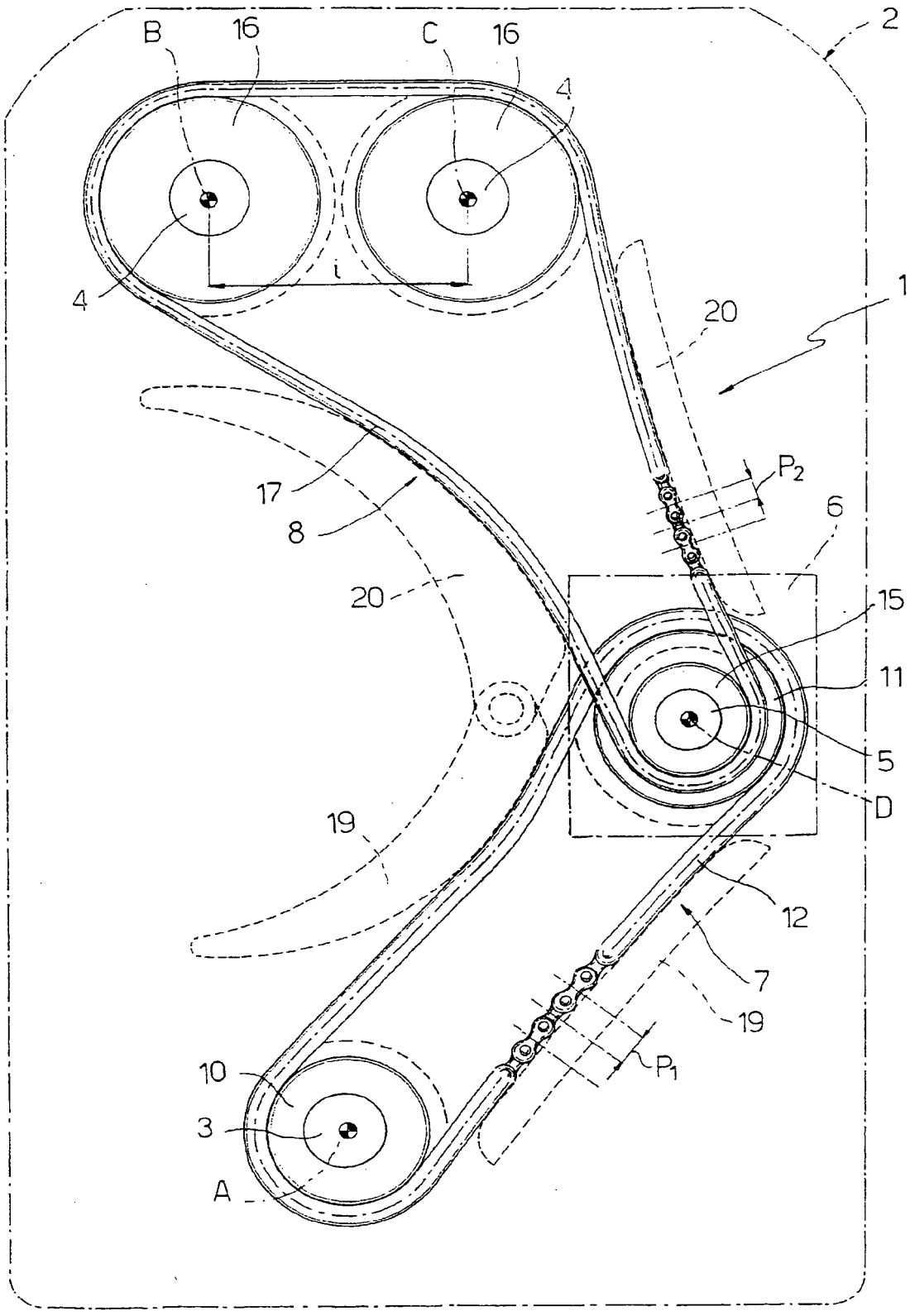
Claims

1. A chain transmission device (1) for controlling the timing system of an internal combustion engine (2) with two overhead camshafts (4), and comprising a first chain transmission (7) from the drive shaft (3) to an intermediate shaft (5), and a second chain transmission from the intermediate shaft (5) to both said camshafts (4); wherein said first transmission (7) defines a step-down transmission ratio (t_1) between said drive shaft (3) and said intermediate shaft (5); and said second transmission (8) defines a step-down transmission ratio (t_2) between the intermediate shaft (5) and the camshafts (4); characterized in that said intermediate shaft (5) is the drive shaft of a fuel pump (6) of said engine (2); and in that the chain (17) of said second transmission (8) has a pitch (p_2) smaller than the pitch (p_1) of the chain (12) of said first transmission (7).

2. A device as claimed in Claim 1, characterized in that said first transmission ratio (t_1) ranges between 1: 2 and 1.

3. A device as claimed in Claim 1 or 2, characterized in that said pump (6) is a high-pressure pump of a storage injection system.

4. A device as claimed in Claim 3, characterized in that said first transmission ratio (t_1) is defined by a fraction $N/2*n_p$, where N is a whole number, and n_p the number of pumping members of the pump (6).



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EUROPEAN SEARCH REPORT

Application Number
EP 99 12 5946

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 4 753 199 A (MELDE-TUCZAI) 28 June 1988 (1988-06-28) * column 1 - column 2; figures 1,2 *	1-3	F01L1/02 F16H7/06
A	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 07, 31 July 1997 (1997-07-31) & JP 09 068007 A (SUZUKI MOTOR CORP), 11 March 1997 (1997-03-11) * abstract *	1,2	
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7) F01L F16H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 July 2000	Flores, E

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82